

Proper registration during the triple printing is secured by making reference marks on the plates. A picture of this sort once produced can be reproduced indefinitely by making contact prints, since the arrangement of the lines will be the same in all of the copies as in the original. The finished picture is perfectly transparent, and is merely a diffraction grating on gelatine with variable spacing. In some parts of the picture there will be a double grating, and in other parts (the whites) there will be a triple set of lines. Having had some difficulty in getting three sets of lines on a single film in such a way as to produce a good white, I have adopted the method of making the red and green gratings on one plate, and the blue on another, and then mounting the two with the films in contact. It is very little trouble to multiply the pictures once the original red-green grating picture is made.

The pictures are viewed with a very simple piece of apparatus, shown in Fig. 4, consisting of a lens cut square like a reading glass, mounted on a light frame provided with a black screen perforated with an eye-hole through which the pictures are viewed. The colours are extremely brilliant, and there is a peculiar fascination in the pictures, since if the viewing apparatus be slowly turned so that its direction with reference to the light varies, the colours change in a most delightful manner, giving us, for example, green roses with red leaves, or blue roses with purple leaves, a feature which should appeal to the impressionists. The reason of this kaleidoscopic effect is evident, for by turning the viewing

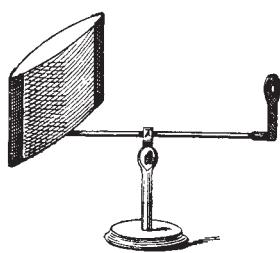


FIG. 4.

apparatus we bring the eye into different parts of the overlapping spectra.

It is possible to project the pictures by employing a very intense light, and placing a projecting lens in place of the eye behind the perforation in the screen. Of course a very large percentage of the light is lost, consequently great amplification cannot well be obtained. I have found that sun-light gives the best results, and have thrown up a three-inch picture on a four-foot sheet so that it could be seen by a fair-sized audience.

By employing a lens of suitable focus it is possible to make the viewing apparatus binocular, for similar sets of superposed spectra are formed on each side of the central image by the gratings, so that we may have two eye-holes if the distance between the spectra corresponds to the interocular distance.

It is interesting to consider that it is theoretically possible to produce one of these diffraction pictures directly in the camera on a single plate. If a photographic plate of fine grain were to be exposed in succession in the camera under red, green, and blue screens, on the surfaces of which diffraction gratings had been ruled or photographed, the plate on development should appear as a coloured positive when seen in the viewing apparatus. I have done this for a single colour, but the commercial plates are too coarse-grained to take the impression of more than a single set of lines. With specially made plates I hope to obtain better results.

R. W. WOOD.

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LOCAL UNIVERSITY COLLEGES FOR LONDON.

THE adequate provision of university education for London is by no means the simple and straightforward task which some people seem to imagine. From whichever of the many possible points of view the question of the education of London is considered, the anomalous position which has to be assigned to the greatest city in the world is the most noteworthy result of the investigation. If, for instance, an endeavour is made to estimate the comparative facilities offered for higher instruction in the metropolis with those to hand in other countries and in our own large provincial towns—judged on a basis of population—the results arrived at are as remarkable as they are interesting and instructive. The population of Scotland in 1896 was 4,186,849; yet located at Edinburgh, Glasgow, Aberdeen and St. Andrews are four well-equipped and largely endowed universities; while, in addition to these, is to be found at Dundee a college providing university education, and, though working with St. Andrews, in receipt of an annual grant of 1000*l.* from the Treasury. The population of the county of London was last year 4,504,766. If, as is done in the University of London Act, 1898, the towns within thirty miles of the university buildings are included, the population must be placed at a very much higher figure, viz. about six millions and three-quarters.

So that, keeping well within limits, and running no risk of any charge of exaggeration, the inhabitants of this metropolitan area may be said to considerably outnumber those of Scotland. When the universities and university colleges provided for this immense population are enumerated the total is ludicrously small. There is no teaching university, and but three university colleges—University College, King's College, and Bedford College. Of course, there are other colleges in London; but, in defining university colleges reference is made to the Treasury Minute of June 2, 1897, dealing with the grant in aid of the university colleges of Great Britain.

At University College there were in the faculties of Arts, Laws, and Science, in the session of 1895-6, 747 students, including engineering students. At King's College, during the same session, there were in Arts and Science 284 day students, 305 evening students, and 315 lady students. At Bedford College, the number of students throughout the same period numbered 176. The total number of persons receiving instruction of university standing in officially recognised institutions was consequently not much over 1500 during the year 1895-6.

If the populations up to date of the eight large towns in England provided with university colleges be added together, the total obtained is about 3,233,765. Similarly, Wales, with a population in 1891 of 1,501,163, has three university colleges, now together constituting the University of Wales. Not only in comparison with Scotland, therefore, but also by the side of Wales and the English provinces, London is seen to be extraordinarily deficient in properly authorised establishments the prime duty of which is to provide university instruction.

It may be urged at this stage that the work of the University of London Commission now being performed will, as it is intended it shall, completely alter the present unsatisfactory aspect of things, and that ere long provisions which will satisfy the most earnest advocate of higher education will be provided. But valuable as the coordination of effort which is likely to result from the inauguration of the new University of London will be, it can hardly be contended that to confer new powers upon certain existing colleges, and to rearrange the work of the staffs of institutions which have previously proved inadequate, will be a complete solution of the proper provision of university instruction for nearly seven millions of people.

It may be said at once that London should have a university college in each one of the various parts of the enormous district it covers. If one of the most important phases of the education imparted by the university is the intimate association of the undergraduate with his professors, the free exchange of views between the students themselves, and that mellowing effect which results from the feeling of a close connection with the corporate life of an important institution—then surely many small universities are incomparably better than one many-sided and multi-tentacled body with which the individual student can have no personal connection.

Nor is this conception of local universities in the different districts which build up the straggling wilderness we call London a dream of Utopia. As has been before pointed out in these columns, there already exist in London eleven polytechnic institutions, and the foundation stone of a twelfth has been laid. These, with four branches which have been established, provide sixteen separate centres scattered throughout an area which extends from Woolwich to Wandsworth in one direction, and from New Cross to Holloway in another. Why cannot some of these extensive buildings and lavishly furnished lecture-rooms and laboratories, representing half a million sterling in capital outlay, be utilised for the purpose of university work?

A reference to previous issues of NATURE will abundantly prove that there is nothing incongruous in undertaking university education in the lecture theatres, class-rooms and laboratories of these polytechnics. Comparatively few additions to the apparatus and fittings already provided would be necessary. Indeed, the work which has already been accomplished, valuable though it is, is scarcely return enough for the munificence of the City companies, the City parochial charities, the London County Council, private donors and others, which has placed the London polytechnics in their present condition of complete equipment.

A common retort to any such suggestion as has now been briefly stated—that the work of a university college is of a much more advanced nature than anything accomplished in a polytechnic—will not bear close examination. Several tests can easily be applied. An inspection of the lists of graduates of the London University; for instance, shows that a comparison of the numbers of successful candidates is all in favour of the polytechnics as compared with the university colleges. As it happens, it is possible to obtain the verdict of former professors of university colleges who are now engaged in the work of the polytechnics, and their assurance is that a greater quantity of advanced work, at all events in science, is done in the polytechnic. Moreover, the amount of work of an advanced type accomplished in English university colleges is usually somewhat exaggerated. A few quotations from a report presented in 1897 by Mr. P. H. Warren, President of Magdalen College, Oxford, and Prof. Livingstone, Fellow of St. John's College, Cambridge, to the Lords Commissioners of her Majesty's Treasury, will justify this statement. Of one university college it is stated, "On the Arts side it cannot be said that at present any amount of work of a high standard is being done in the college," or later, "most of the work, both in arts and science, is of an elementary kind." Of another similar place of instruction, "With regard to the work now being done there, judged by University standards, a good deal of it is of an educational and preparatory rather than of an advanced and learned character." In the case of another college, "It is, therefore, not to be wondered at that the work on the Arts side should be still in a somewhat incipient stage, and mainly educational rather than learned." Of a fourth

college it is reported, "A great deal of this work is in the nature of things of a somewhat preparatory kind, and there is throughout the college a great deal of work of not a very advanced character." Similar remarks concerning other university colleges might be multiplied, but quotations enough have been made to show that in apportioning the Treasury grant to university colleges the mere fact that elementary instruction is a part of the work carried on in the buildings is not considered a disqualification for also undertaking university instruction.

It is true that a very large part of the instruction of the 50,000 members and students enrolled by the London polytechnics takes place in the evening. This has been urged as evidence of the wide disparity between the methods of polytechnics and those of university colleges, but such an allegation reveals a want of knowledge of the prevalent conditions of instruction in university colleges. The evening classes of King's College, London, form an important part of the whole work of the institution. At Owens College, Manchester, a very complete system of evening lectures has been arranged for schoolmasters and others engaged during the day. The evening classes at University College, Liverpool, are strong and well attended, and are encouraged by the College authorities. The number of evening class students at Mason College, Birmingham, steadily increases. Besides the regular day work of the Bristol University College, there is an extensive system of evening classes, covering almost all the subjects taught in the college. At the Durham College of Science, Newcastle-upon-Tyne, there were in 1895-6, 1092 evening students compared with 499 day students. At Nottingham, in 1894-5, there were more than three evening students to one attending during the day.

Attention has already been called (No. 1523, p. 236) to the very complete arrangements in some of the polytechnics for instruction in the methods of scientific research, and to the excellent results, as evidenced by papers read to the learned societies, which have followed the lectures and demonstrations.

It would consequently appear that a judicious system of coordination and a little levelling-up would convert some of these sixteen institutions, which in the past ten years have had a phenomenal growth, and are steadily improving in status and influence, into satisfactory university colleges, bringing the highest order of culture to the very doors of the so-called metropolitan Philistines.

THE PLANS FOR ANTARCTIC EXPLORATION.

IT is understood that the German Antarctic expedition for the year 1901 has now been fully organised. A grant of 60,000*l.* towards the expenses has been made by the Reichstag. Dr. Erich von Drygalski, one of the professors of geography in the University of Berlin, has been appointed the scientific leader, and an influential Committee is charged with perfecting the arrangements. This Committee is anxious that all the plans should be arranged for joint action, so that the German and British expeditions should supplement and reinforce one another at every point, thus ensuring the maximum return of scientific knowledge for the money expended. The expedition of the *Valdivia*, under the scientific leadership of Prof. Chun, is a proof of the splendid results which attend deep-sea expeditions under a scientific chief, if indeed the *Challenger* expedition did not supply proof enough. It is, however, still the opinion of some authorities in this country that an expedition which has to be carried in a ship must be under the sole and exclusive charge of a naval officer. The subject is one which